

and should be still further limited in small local companies. A safe plan would be to place no more risks in positions such that all might be lost in a single tornado, than the company would be willing to carry as a single risk.

## CONCLUSIONS.

Tornado insurance is a legitimate form of insurance and is a valuable protection in large portions of the United States. It now properly covers loss or damage from other windstorms since the distinction is a technical and scientific one. The business can be conducted on such sound principles and at such reasonable rates that it shall bring a just profit to the companies and at the same time give valuable protection, without burden to the insured.

This end can only be attained by the establishment of the business on a scientific basis, such as that on which fire insurance now rests. This basis is being approached by the better companies, but the end may be sooner reached by the active cooperation of those interested in insurance and meteorology.

The meteorologists working on the well-founded theories of Ferrel and along the lines of statistical research so well begun by Finley, Hazen, Henry, and Abbe could determine the hazard and predict the losses for all portions of the United States, preferably by unit areas within State lines.

The insurance companies could, by a careful separation of the windstorm business from the other forms of insurance with which it is now confused, also determine the hazard and predict the losses in the territory in which they are working. They could in addition predict the expenses and adjust the premiums accordingly.

Cooperation in this line would bring about a more equitable adjustment of rates, a general reduction of the cost of windstorm insurance, and increased security to both the companies and their patrons.

The Census Bureau could render most valuable assistance to this very important branch of business by again taking up the compilation of statistics on insurance so unfortunately omitted by the Twelfth Census.

The departments of insurance in the individual States could render great service by requiring careful reports on all tornado business, by enforcing certain necessary restrictions on the companies incorporated or operating within their States, and by recommending such legislation as would secure for their people insurance at the lowest cost consistent with safety to the insured and just remuneration to the insurer.

## REFERENCES.

The following list of references will be found of value to anyone desiring to make a study of this subject. Those marked thus (\*) have been found of special value in the preparation of this report:

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## NORWAY'S CONTRIBUTIONS TO THE NATURAL SCIENCES.

By R. S. N. SARTZ. Dated Weather Bureau, Washington, D. C., October 25, 1905.

Norway, the land of the midnight sun, with scarcely two million inhabitants, can well be proud of her contributions to the world's progress in the past hundred years.

That the traditions of the old Vikings should still be able to inspire a Nansen and a Sverdrup to brave the dangers and seek fame and adventure by exploring the regions around the North Pole, as did their ancestors of old, seems natural enough. That the grandeur and beauty of the natural scenery, the almost incredibly brilliant coloring of the arctic night, where the midnight sun gives way to a moon so bright that one can read the finest printed book by its light, where the aurora borealis seems only an incident in the brilliantly illuminated heavens, should stimulate the imagination and create poets of high order, is easy to understand. Ibsen, Bjornsen, Garborg, Kjelland, Lie,<sup>1</sup> and others are the high priests of the Arctic, as are Grieg, Svendsen, and others its singers. They set to words and music a nature so grand that it would seem strange indeed if works, thus inspired, should not compare favorably with the literature and music of the rest of the world. But in the realm of exact science we should not expect to find the little country represented on the ladder of progress, and even at the very top.

It is, however, a fact that Norway has the distinction of having produced the two greatest mathematicians of the nineteenth century. Nils Henrik Abel, who was born August 5, 1802, and died in 1829, held the helm in the beginning of the century, and Sophus Lie (born in 1842, died in 1898) has been recognized as the greatest mathematical genius at the end of the same century. Abel's discoveries in the realm of algebra and Lie's in that of geometry are known to the scientific world, and we need but mention them here. Among other distinguished Norwegian scientists, we recall the following:

Christoffer Hansteen (1784-1873), the first professor of applied mathematics and astronomy in the University of Christiania, was, in his day, one of the most famous scientists of Europe. He explored Siberia, located the north magnetic pole and founded the Observatory of Christiania, thereby opening the way for the introduction into Norway of the then new branches of science, magnetism and meteorology.

Ole Jakob Broch (1818-1882), professor of pure mathematics in the University of Christiania, had a world-wide reputation in science, and was also a noted statesman and political economist. He was for many years a member of the Storting (the Norwegian congress), and served a few years as secretary of the treasury. He was Norway's delegate to the International Monetary Conference at Paris, 1871, and made one of the best

<sup>1</sup> Pronounced "Lee."

received and most noted speeches in favor of the gold standard. His last ten years he spent in Paris, having been elected director of the International Bureau of Weights and Measures, located at Sevres. The physical data compiled by him for the first volume of the annals of that bureau were adopted as the basis of the international meteorological tables.

C. A. Bjerknes (1825-1903), professor of applied mathematics in the University of Christiania, was a contemporary and a collaborator of O. J. Broch, and his name must be mentioned whenever the history of natural science shall be written. His researches in the realm of magnetism and electricity attracted wide attention in the seventies and eighties. He wrote a very well received biography of Nils Henrik Abel, of whom he was a great admirer, having been active in calling the attention of his countrymen to the importance of the works of this profound genius. The results of his hydrodynamic researches are known as the C. A. Bjerknes Theory. His biography as published lately is a wonderful tale of struggle against disease and blindness.

Cato Maximilian Guldberg (1835-1902), Bjerknes' successor as professor of applied mathematics, was a versatile scientist. He is equally well known in the realms of astronomy, physics, and chemistry. In conjunction with his contemporary, Professor Waage, who conducted the chemical experiments, he applied the principles of mechanics to the phenomena of molecular attraction, supposed to exist between the smallest particles of matter, thereby practically raising the theory of chemical affinity and the science of chemistry from an experimental to an exact deductive stage. The results of his researches were first published in 1869 (*"Études sur les affinités chimiques"*), and his theory is known as the Guldberg-Waage-Law theory. Guldberg's style in his writings was brief and to the point. Together with Prof. Henrik Mohn, of Christiania, he published *"Hvirvel Centrernes Theori (Études sur les mouvements de l'atmosphère)"*, a very important work on the fundamental principles of meteorology.

Axel Sofus Guldberg, a younger brother of the above, is the author of the text-book in astronomy now used in the University of Christiania. The spirit of the Norwegian astronomer is shown by the following quotation from the Bible: "Canst thou bind the sweet influences of the Pleiades or loose the bands of Orion?" (Job xxxviii, 31.)

Wilhelm Friman Koren Bjerknes, born 1862, son of Prof. C. A. Bjerknes, when a young student took deep interest in his father's hydrodynamic researches. He was a pupil of Poincaré at Paris, and Hertz at Bonn, and was very active in the work connected with the so-called Hertzian waves, succeeding in explaining some points in their theory that had till then been misunderstood. He took his doctor's degree in 1892 and has since 1895 been professor in the school for mechanics and physics of the Stockholm University. He has published *"Vorlesungen über hydrodynamische Fernkräfte nach C. A. Bjerknes' Theorie."* He is considered the highest living authority in the study of the mechanics of fluids.

Kristian Birkeland, born 1867, and professor of physics in the University of Christiania, has attracted attention by his researches on the origin of the northern light (aurora borealis). His *"Recherches sur les taches du soleil et leur origine"* sets forth his whole theory. He has made some important practical inventions. His invention of a method of utilizing atmospheric electricity for fertilizing purposes has been taken up by a stock company that has made some very successful experiments.

It was quite natural that a country with such an extended coast line, where the inhabitants mainly follow the sea for a living, should early awaken to the vital importance of meteorology to the safety of life. The Meteorological Institute at

Christiania was established by Prof. Henrik Mohn, who still remains the head of that institution, where he has achieved many a meteorological triumph and has been the means of saving thousands of lives and millions in property. Before the establishment of the institution, about 1867, it was an almost yearly occurrence to have hundreds of fishermen and their boats destroyed by storms that even the experienced eye of the fisherman could not discover beforehand. Now such sad disasters are rarely heard of. To the Norwegian fisherman the Meteorological Institute is no joke; it is the one government institution he can endorse and feel grateful for.

Prof. Henrik Mohn, the first professor of meteorology in the University of Christiania and director of the Meteorological Institute, was born in 1835. He was the leader of the Norwegian Arctic Expedition, 1882-1883, the results of which were published in 1887. To him belongs the credit for having established meteorological stations as far north as possible, thereby contributing considerably to our meteorological knowledge of the globe. He also established a meteorological service for the Arctic Ocean, having secured the services of the captains of the Norwegian fishing vessels as voluntary observers. His treatise *"Grundzüge der Meteorologie"* (9th Ed. Berlin, 1883) has been translated into most modern languages and is considered a handbook of great value. Other publications by him are: *"Température de la mer entre l'Irland, l'Ecosse et la Norvege,"* (Christiania 1870), *"Oversigt over Norges Klimatologi"* (Christiania 1870), and, together with Professor Guldberg, *"Hvirvel Centrernes Theori,"* or *"Études sur les mouvements de l'atmosphère."* He has also just now edited the volume of meteorological results of Professor Nansen's Arctic Expedition.

#### A VISIT TO EUROPEAN OBSERVATORIES.

By GERALD J. O'CONNOR. Dated St. Louis, Mo., October 5-November 25, 1905.

A few observations made in the months of July and August, 1905, while touring in foreign lands, may be worthy of publication in the MONTHLY WEATHER REVIEW.

The itinerary included France, Italy, Switzerland, western Germany, Belgium, England, and Ireland.

While in London the opportunity was afforded me of visiting the Royal Observatory at Greenwich, from whose meridian longitudes are counted by nearly all nations. This observatory stands on an eminence about five miles southeast of London Bridge. A castle had been erected on this site in the reign of Henry V. During succeeding reigns it was occupied as a residence by members of the royal family, and in Queen Elizabeth's time it was used as a prison. In the reign of Charles II it was converted to its present use as an observatory, Sir Christopher Wren making the necessary alterations in 1675. The post of astronomer royal has been successively held by John Flamsteed, 1675-1719; Doctor Halley, 1720-1742; Doctor Bradley, 1742-1762; Nathaniel Bliss, 1762-1764; Doctor Maskelyne, 1765-1811; John Pond, 1811-1835; Sir George B. Airy, 1835 to 1881, when the present astronomer royal, Sir W. H. M. Christie, was appointed.

It was during the administration of Sir George B. Airy that the work was made to include meteorological observations and instruments for continuously recording atmospheric phenomena. Among instruments not ordinarily found at Weather Bureau stations in the United States is one for registering the pressure of the wind on a surface.

The central office for the collection and dissemination of weather information in France is at No. 176 Rue de l'Université, in Paris. Observations of temperature, precipitation, and wind direction and velocity are taken at a convenient time between 7 and 8 a. m., at fifteen stations within the city limits. One of these local observatories is at the summit of the Eiffel Tower; another in the tower of St. Jacques. I visited both of these. At the latter a daily map and forecast of "proba-